CLAIMS

1. A robot hand including a plurality of finger mechanisms corresponding to a plurality of human fingers, respectively, each of said finger mechanisms being constituted by a plurality of phalange sections including a distal phalange section and a middle phalange section adjacent to the distal phalange section, said robot hand comprising:

a fingertip rotating mechanism that causes the distal phalange section to rotate relative to the middle phalange section in two directions comprising an inward direction and an outward direction within a predetermined angular range, from a state where the distal phalange section is arranged in a straight line with the middle phalange section.

2. The robot hand according to claim 1, further comprising:

a rotation driving mechanism that causes a first finger mechanism corresponding to a human thumb among said finger mechanisms to rotate by a predetermined angle about a center line extending in a direction where the phalange sections constituting said first finger mechanism are arranged so that said first finger mechanism fully facing the other finger mechanism.

3. The robot hand according to claim 1, wherein

the fingertip rotating mechanism includes at a connecting portion between the distal phalange section and the middle phalange section a single degree of freedom joint for allowing bending or stretching and also includes a driving mechanism that causes the joint to make a rotating motion within the predetermined angular range; and

the joint and the driving mechanism are configured so that the distal phalange section can be rotated relative to the middle phalange section in the two directions, namely, the inward direction and the outward direction within the predetermined angular range from the state where the distal phalange section is arranged in a straight line with the middle phalange section.

4. The robot hand according to claim 3, wherein the driving mechanism comprises a motor for driving the joint and a speed reducer, the motor for driving the joint being included in the middle phalange section and generating a driving force for rotating the joint, the speed reducer reducing a speed of the motor and transmitting the reduced speed to the joint.

5. The robot hand according to claim 4, wherein the speed reducer comprises:

a first pinion gear fixed to an output shaft of the motor;

a first spur gear that is fixed to a rotary shaft rotatably supported by the middle phalange section and meshes with the first pinion gear;

a second pinion gear fixed to the rotary shaft; and

a second spur gear that is fixed to the distal phalange section so that a rotation center of the joint becomes a rotation center of the second spur gear and meshes with the second pinion gear.

6. The robot hand according to claim 4, wherein

each of the distal phalange section and the middle phalange section includes a first sidewall portion and a second sidewall portion facing to each other in a width direction thereof;

the joint is provided so that the first and second sidewall portions of the distal phalange section and the first and second side wall portions of the middle phalange section are rotatably jointed;

the motor is arranged between the first and second sidewall portions of the middle phalange section so that an axis line of the output shaft extends in the width direction;

an axis line of the rotary shaft that supports the first spur gear and a rotation center line of the second spur gear both become parallel to the axis line of the output shaft; and

the first spur gear is arranged to be along the first

side wall portion of the middle phalange section and the second spur gear is arranged to be along the first side wall portion of the distal phalange section, respectively, the first side wall portion of the middle phalange section being located in a direction where the output shaft of the motor protrudes.

7. The robot hand according to claim 6, wherein

the output shaft of the motor is rotatably supported by the first side wall portion of the middle phalange section, and a housing for the motor is supported by the second side wall portion of the middle phalange section;

the rotary shaft is supported by the first side wall portion of the middle phalange section; and

the second spur gear is fixed to the first side wall portion of the distal phalange section.

8. The robot hand according to claim 7, wherein a rotational position sensor that detects a rotational position of the distal phalange section is attached to the second side wall portion of the middle phalange section.

9. The robot hand according to claim 2, wherein

said first finger mechanism includes the distal phalange section, the middle phalange section, and a proximal phalange section in order from a fingertip thereof;

the proximal phalange section includes a first proximal phalange half portion and a second proximal phalange half portion which are formed by dividing the proximal phalange section so that the first and second proximal phalange half portions may be located in a direction where the proximal phalange section and the metacarpal section are arranged;

the first proximal phalange half portion is located on a side of the metacarpal section, and the second proximal phalange half portion is located on a side of the middle phalange section;

between the first proximal phalange half portion and the second proximal phalange half portion, a single degree of freedom rotary joint is included, said rotary joint allowing the second proximal phalange half portion to rotate relative to the first proximal phalange half portion within the predetermined angular range so that the second proximal phalange section may rotate about the center line passing through a center of the first proximal phalange half portion and a center of the second proximal phalange half portion;

a driving mechanism for driving the rotary joint that causes said rotary joint to make a rotating motion within the predetermined angular range is also included; and

said rotary joint and said driving mechanism for driving the rotary joint comprise said rotation driving mechanism.

10. The robot hand according to claim 9, wherein

said driving mechanism for driving the rotary joint comprises a motor for driving the rotary joint attached to said first proximal phalange half portion and a speed reducer that reduces a speed of said motor and transmits the reduced speed to said rotary joint, said motor generating a driving force for rotating said rotary joint; and

said speed reducer comprises:

a first pinion gear fixed to an output shaft of said motor;

a first spur gear that is fixed to a rotary shaft rotatably supported by said first proximal phalange half portion and meshes with said first pinion gear;

a second pinion gear fixed to said rotary shaft; and

a second spur gear that is fixed to said second proximal phalange half portion so that a rotation center of said rotary joint becomes a rotation center of said second spur gear and meshes with said second pinion gear.

11. The robot hand according to claim 1, wherein a pressure sensor for measuring a contact pressure distribution is attached to an outer surface of a palm-side portion of the distal phalange section.

12. A robot hand comprising five finger mechanisms

corresponding to first through fifth fingers of a human being and a palm portion which supports said five finger mechanisms and corresponds to a palm of the human being,

each of said five finger mechanisms corresponding to said first through fifth fingers comprising a distal phalange section, a middle phalange section, and a proximal phalange section, in order from a fingertip thereof, at least a single degree of freedom joint for allowing bending or stretching at a connecting portion between the distal phalange section and the middle phalange section, and also a driving mechanism that causes the joint to perform a rotating motion within a predetermined angular range, wherein

the driving mechanism comprises:

a motor for driving the joint that is included in the middle phalange section and generates a driving force for rotating the joint; and

a speed reducer that reduces a speed of the motor and transmits the reduced speed to the joint; and

the joint and the driving mechanism are configured so that the distal phalange section can be rotated relative to the middle phalange section in two directions comprising an inward direction and an outward direction within the predetermined angular range, from a state where the distal phalange section is arranged in a straight line with the middle phalange section.